

# **Barriers to WDM Deployment on Military Platforms**

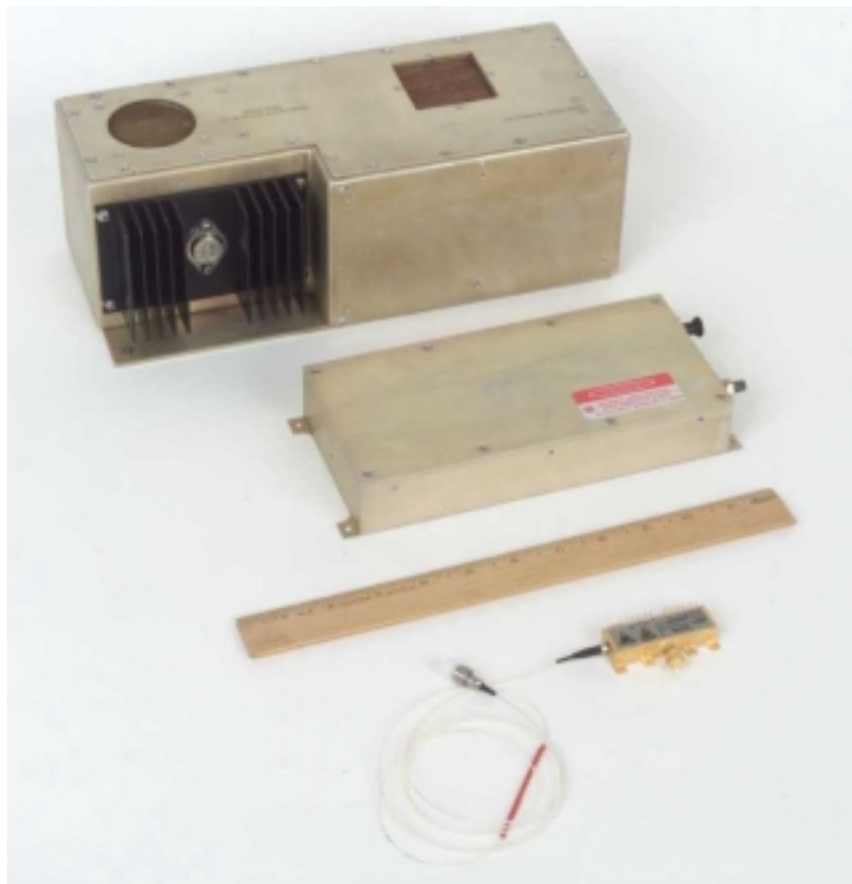
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**DARPA/MTO  
WDM for Military Platforms Workshop  
18 April 2000**

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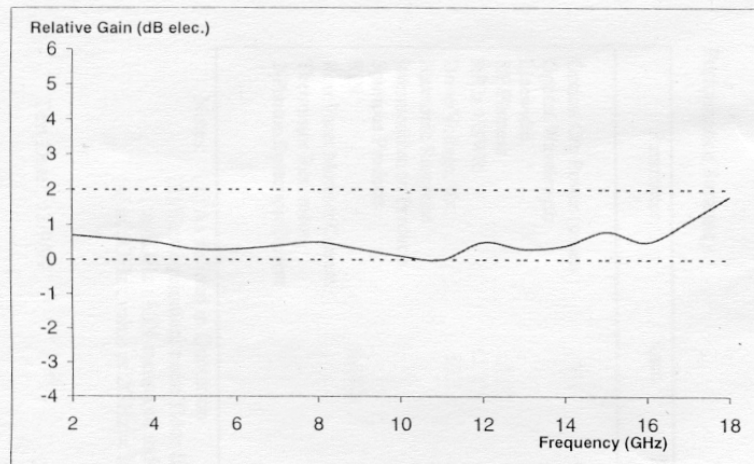
# Militarized (Flight-Qualified) 18 GHz Single-Mode Transmitters

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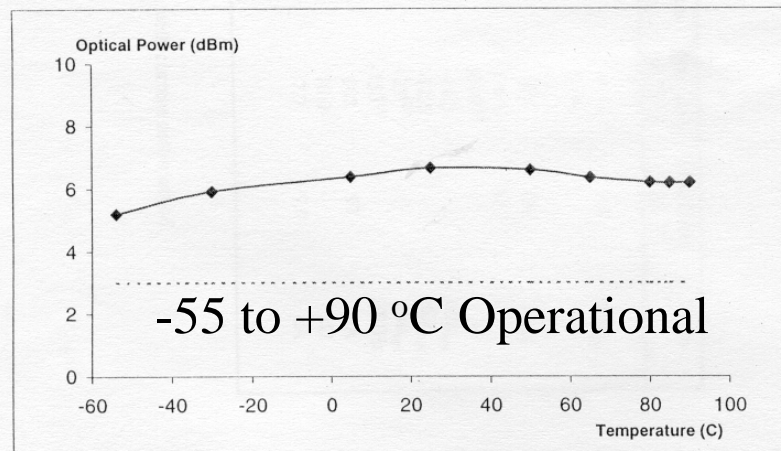


**Mature, Military Hardware for Point-to-Point Applications**

RF Flatness over Frequency @ 90C

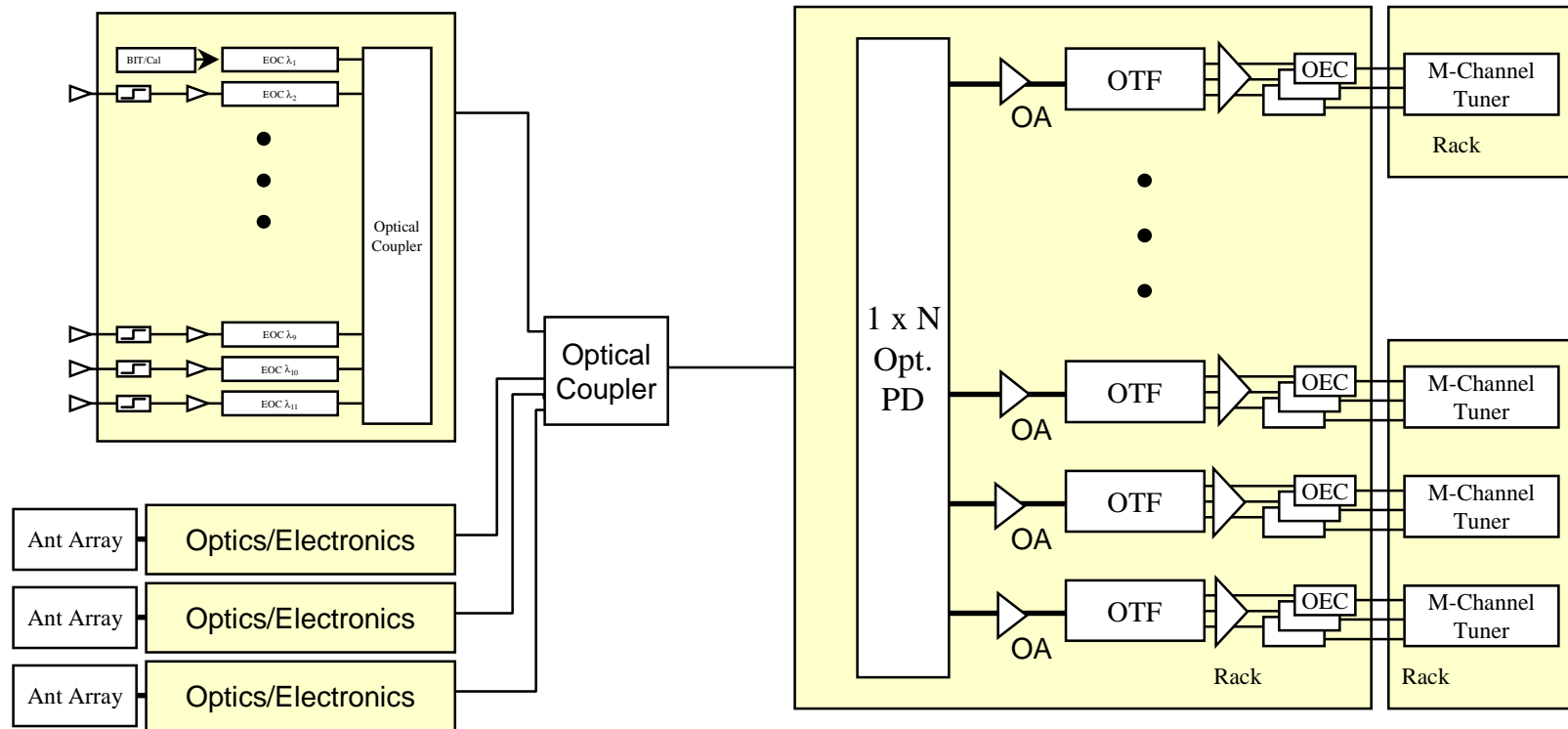


Mean Optical Output Power vs. Temperature



# Generic WDM for Non-Blocking, Full Broadcast Antenna Selection

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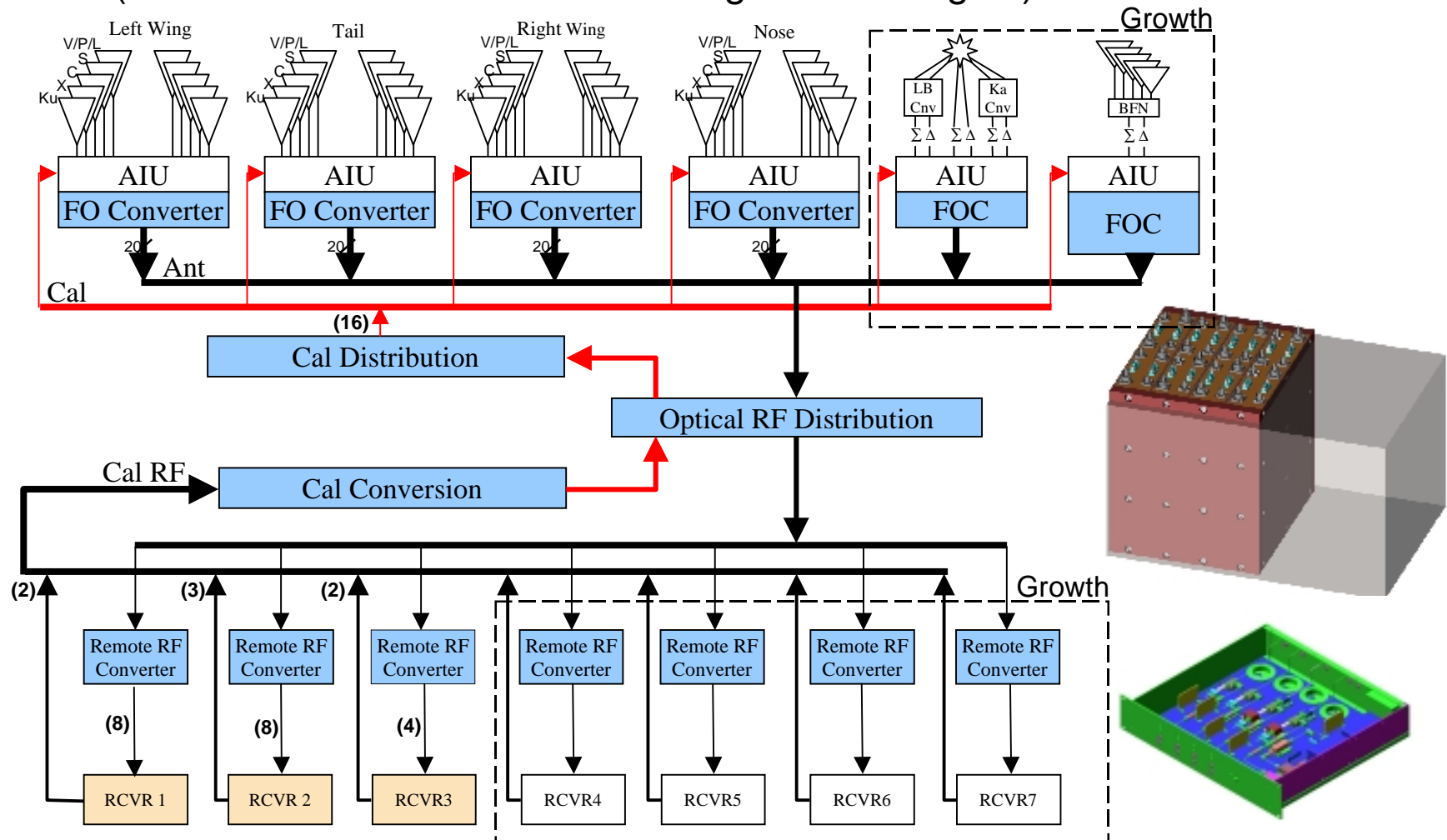
WDM Fiber Network Replacing Conventional RF Cabling, Optical Power Divider (PD) and Optical Tunable Filters (OTF) Replacing Conventional RF Switch; All Antenna Signals Available at Each Receiver

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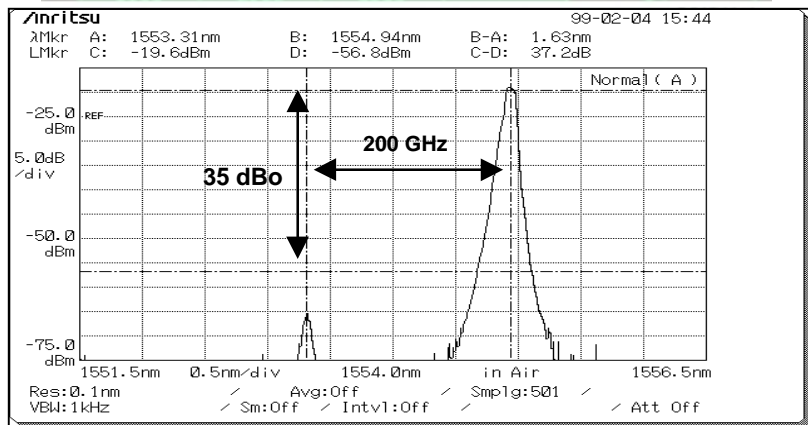
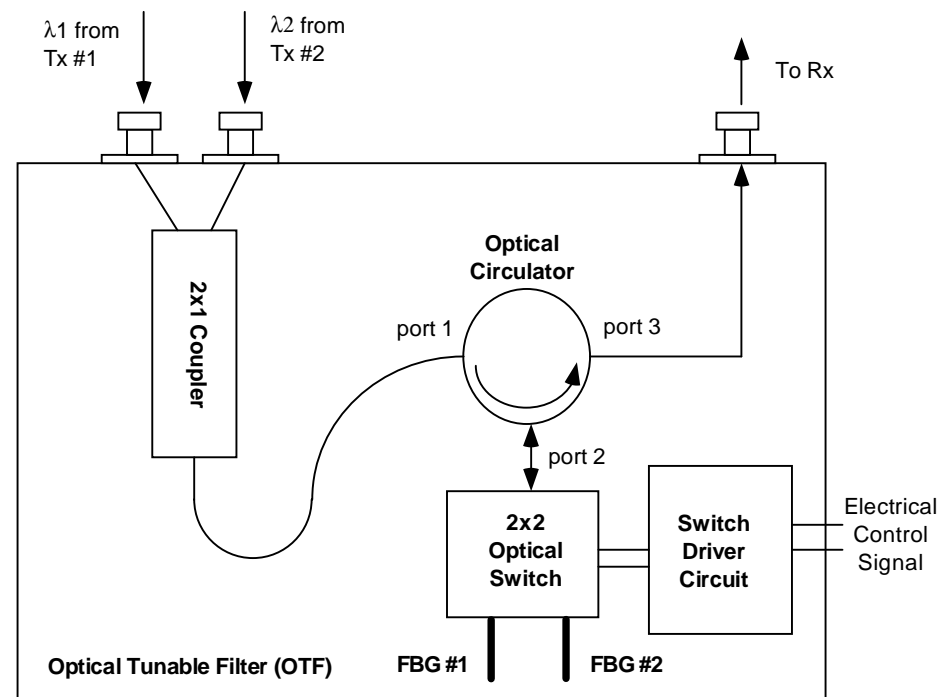
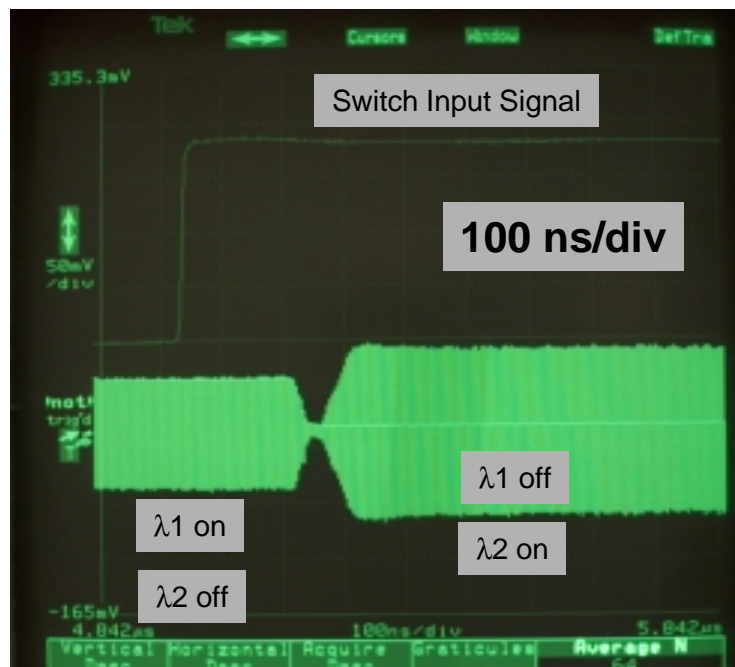
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# Current Analog 18 GHz Link WDM System

(80 Antennas to 16 Receivers using 4 Wavelengths)

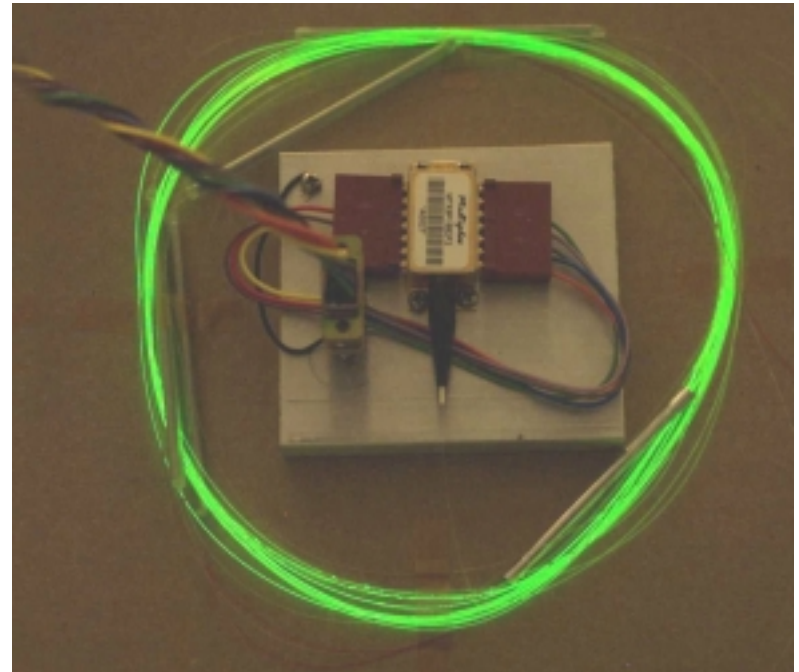
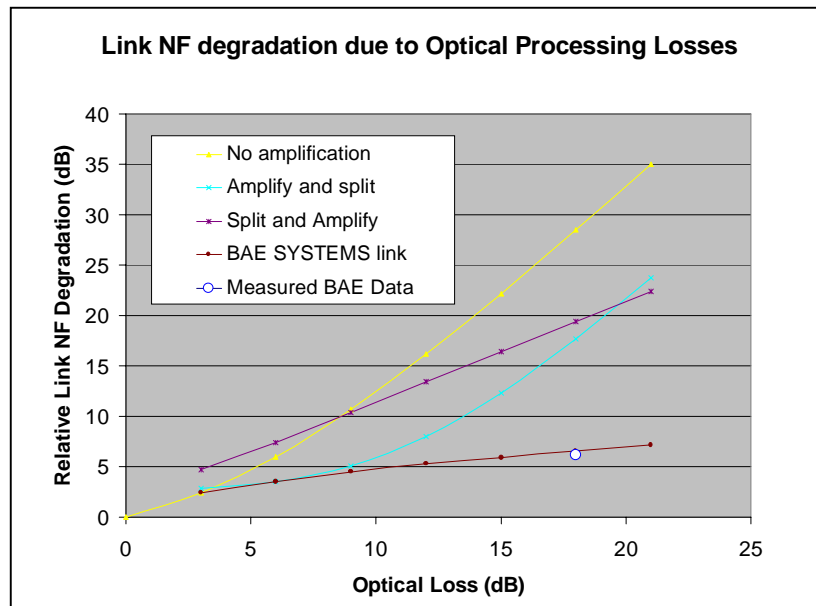


# Dual Channel (10.1 and 10.5 GHz) Switching (Optical Tunable Filter)



**Switching Speed ~80 ns**  
**RF Crosstalk <-76 dBc**  
**RF Bandwidth 18 GHz**  
**Insertion Loss ~8 dBc**

# Low Noise Optically Amplified Microwave Links



BAE SYSTEMS has developed proprietary technology to reduce the noise figure ( $RIN \sim -157$  dB/Hz) of fiber optic microwave links with high optical processing losses due to WDM, switching, and other distribution components.

# Desparately Needed Developments to Enable Replacement of RF Switches

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- **Low Insertion Loss, High-Speed Switches**
  - 10 ms SONET Switching is Too Slow for Military Applications
  - $<10 \mu\text{s}$  is Typical Requirement ( $<100 \text{ ns}$  for High POI Appl.)
  - Narrow Bandwidth (FP), High-Speed Switches Don't Help!!
- **Low-RIN EDFAs**
  - WDM Requires Muxing and Demuxing Multiple Channels
  - EDFAs **ALWAYS** Degrade Analog Link Performance
  - EDFA RIN Must be Reduced Below  $-155 \text{ dB/Hz}$
- **High Crosstalk Suppression Between WDM Channels (Optical Switches for Tunable  $\lambda$  Filtering)**
  - Easy for Narrowband RF Signals ( $<1 \text{ GHz}$ )
  - Difficult for 18 GHz and Higher Sidebands
    - Fiber Bragg Gratings are the Only Demonstrated Technology to Achieve  $> 35 \text{ dBo}$  Crosstalk Suppression for 18 GHz Sidebands
- **High-Power WDM DFB Arrays**
  - $>40 \text{ mW/Channel}$  @  $\text{RIN} < -160 \text{ dB/Hz}$ ,  $< 1 \text{ MHz}$  Linewidth